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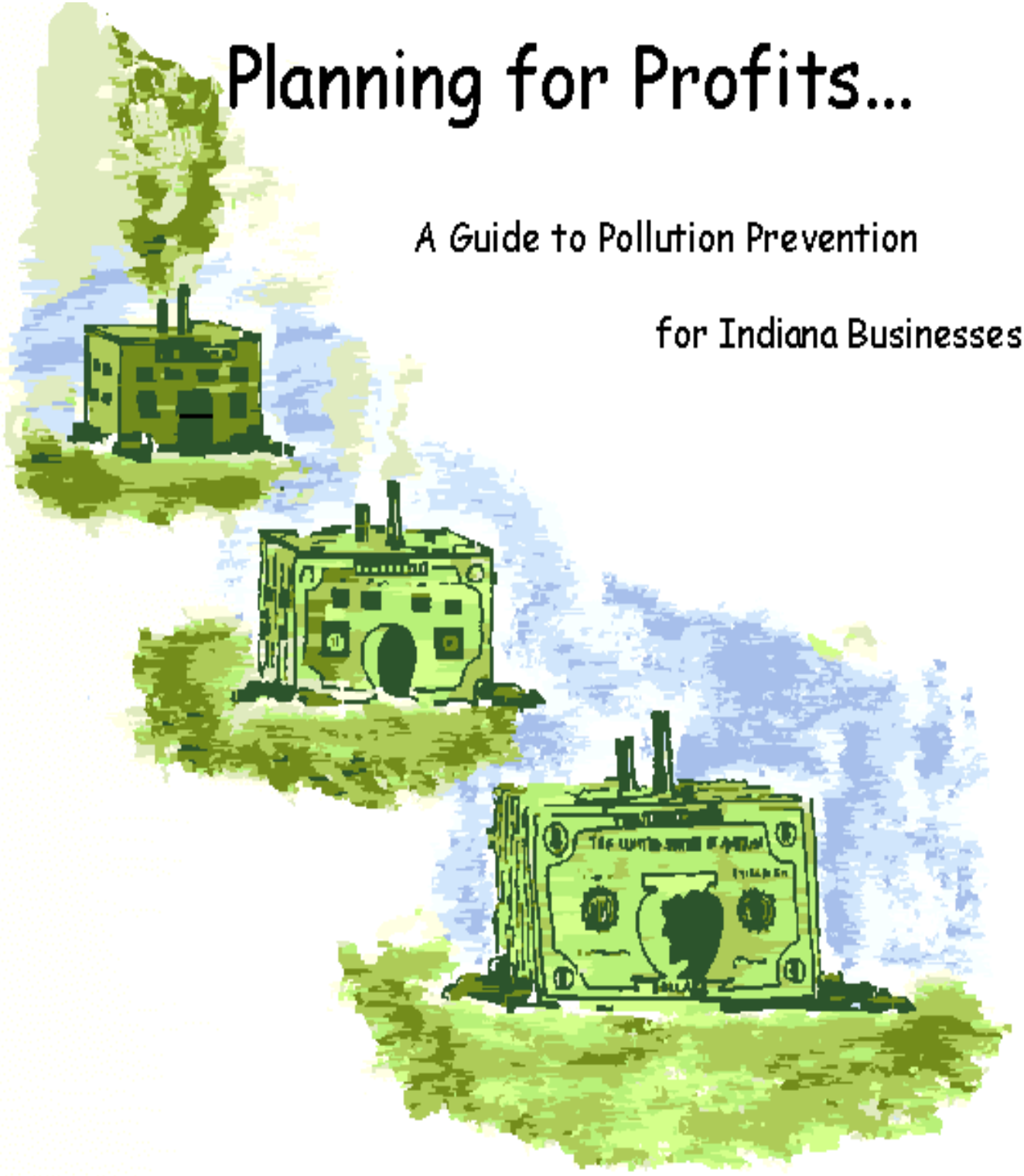
Planning for Profits...

A Guide to Pollution Prevention

for Indiana Businesses



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Planning for Profits…

A Guide to Pollution Prevention

for

Indiana Businesses

Prepared for:
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Office of Pollution Prevention and Technical Assistance
Pollution Prevention (P2) Branch

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This guide is an adaptation of a document developed by the New Hampshire Department of Environmental Services Pollution Prevention Program, with grant funding from the U.S. Environmental Protection Agency-Region 1.

The guide's approach and the tools presented are derived in large part from Robert Pojasek's "Systems Approach to Pollution Prevention" and from pollution prevention manuals from other states.

OFFICE OF THE GOVERNOR
INDIANAPOLIS, INDIANA 46204-2797

FRANK O'BANNON
GOVERNOR

December 19, 2001

Dear Colleague:

The success of Indiana's expanding economy has always been closely tied to the vitality of its natural environment. Our progressive economy is based on a strong commitment to excellence and innovation by state officials, business leaders, private and not-for-profit organizations, and our universities who work together to produce new ideas that build upon existing accomplishments. That same philosophy of commitment and innovation has made Indiana a cleaner, healthier place to live.

Pollution Prevention has emerged as one of the major environmental management strategies for guiding us into this century. Preventing pollution at the source, rather than controlling it after it has been created, promotes prosperity without pollution. Using Pollution Prevention as part of their operating culture, many Indiana businesses have applied common sense techniques and Hoosier ingenuity to their operations to improve productivity while decreasing and eliminating the waste generated.

Because I am dedicated to the development and the maintenance of a broad and constructive infrastructure within which all Indiana businesses can grow and prosper, I am pleased to offer you the Indiana Department of Environmental Management's, "Planning for Profits…A Guide to Pollution Prevention". The guide is for all Indiana businesses that do not have readily available resources, or can not afford professional services to complete their pollution prevention planning process.

We hope that you will take the time to read and use this guide. Good business and a healthy environment go hand in hand, as many Indiana business owners have learned.

Sincerely,

Frank O'Bannon

Frank O'Bannon

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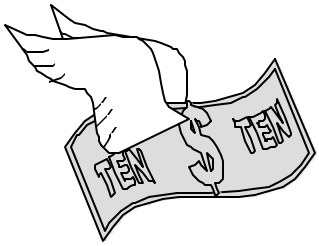
NOTES

Introduction
Planning for Profits

"All waste is lost profit."
-Adolph Coors

How can this guide help me?

DYLQJV If you knew there were $100 bills hidden in you facility, would you take a good look around? Of course! By taking a critical **L◎◎K** at your facility's operations, you can find ways to save money and improve efficiency. How? By reducing WASTE. Waste means any material, energy, or other resources not incorporated into a product. These resources may be lost in the form of air emissions, water discharges, solid and hazardous waste, or heat.



When your company generates waste, it means you're not using resources efficiently. You're losing money through sewer pipes, air vents, and waste shipments. So, the trick is to find the cash hidden in your facility before it has a chance to escape.

This guide can help your company reduce waste generation at it's source—BEFORE it becomes a pollutant or "lost" resource. That is what pollution prevention is all about. Pollution prevention may be as simple as improving preventive maintenance and fixing leaks. It may also involve upgrading to an energy-saving technology, substituting non-toxic for toxic materials, or making a fundamental change in product composition.

If you want to increase profits and reduce your company's impact on the environment, this guide is for you.

How do I use this guide?

This guide takes you step-by-step through the process of pollution prevention planning. First, use the manual as a framework for analyzing operations to understand where and why your company generates waste. In doing so, you'll be able to define hidden costs these wastes impose on your company. Next, try some of the ideas presented in the guide. Finally, consider making pollution prevention planning a part of your overall business strategy.

Many of the tools presented allow you to create charts, diagrams, or other graphics that can serve as effective visuals to discuss environmental issues with employees or management. Because this guide is a generalized overview of pollution prevention planning, you will want to adapt the approaches for your facility's needs.

Throughout this guide, shaded boxes will refer you to Appendices containing worksheets and other helpful information.

Introducing Indiana Bearing Products

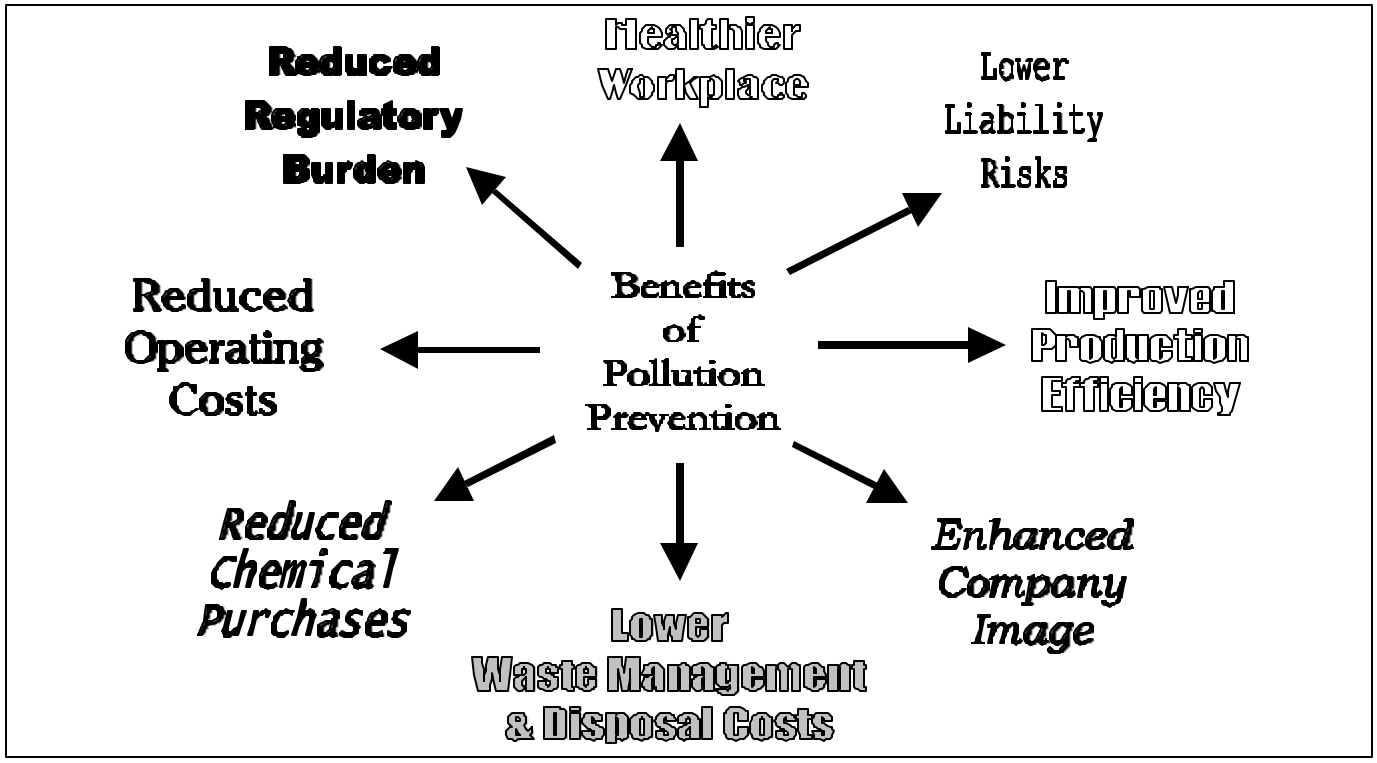
To better illustrate pollution prevention planning in action, this guide follows a fictitious company, Indiana Bearing Products, as it goes through the planning process. A small job shop with about 50 employees, the company manufactures custom-made ball bearing seals and other molded rubber/metal bonded parts.

Indiana Bearing Products has always prided itself on its quality manufacturing process, but the company recently received a couple of minor compliance violations, and waste disposal costs seemed to be increasing out of control. Although the company has enjoyed steady growth since it was formed 10 years ago, the management team felt that continuing this trend was going to be possible only if they approached these environmental challenges in a more **systematic** way. Indiana Bearing Products needed a way to anticipate potential problems, instead of simply reacting to them as they arose.

The quality assurance manager, who was given the lead on this project, didn't quite know how to get started. To get some ideas, he called the Office of Pollution Prevention and Technical Assistance (OPPTA). OPPTA helps industries in Indiana work through the same pollution prevention planning steps you'll find in this guide. Just look for this Indiana Bearing Products logo in each section to see the planning process in action.

Need a Hand?
If you need help with any of the pollution prevention planning steps, see Appendix A. It contains a list of Indiana's technical assistance resources.

Turn the page to see an overview of the pollution prevention planning process…otherwise known as the "Six Steps to Savings." Then each section that follows corresponds to a step in the planning process.



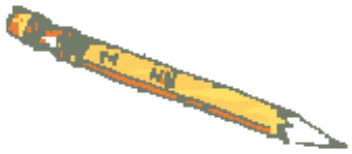
Pollution Prevention Planning:

An Overview

Six Steps

Step ①

Get Organized



Make sure **MANAGEMENT** supports the effort to investigate pollution prevention opportunities and make changes.

Form a Planning Team. Individuals from different departments of the plant can play roles in each step of the planning process.

Let everybody know what's going on. **SEEK INPUT** from personnel at all levels. They are your most valuable asset.

Step ②

Analyze Processes

Take a critical look at each step of your production process, from purchasing raw materials to shipping finished product.

Pinpoint where materials are used and where wastes are generated.

Figure out **TRUE COSTS** of waste generation, including disposal and regulatory costs.

These costs, along with other factors, will help you Prioritize losses and **TARGET** your pollution prevention efforts.

Step ③

Identify Alternatives

The first step to finding effective ways to reduce material losses is to get at the **ROOT CAUSE** of the problem. What factors are responsible for creating the waste? Poor equipment maintenance? Type of raw materials used? Scheduling?

Once you've figured this out, it's time to be creative. List as many alternatives as possible for reducing loss.

Use group brainstorming, employee incentives, or outside assistance to generate lots of ideas.

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to

Step ④

Evaluate Alternatives

You may be able to implement the easy, inexpensive projects right away without further study.

For more complex alternatives, determine which are feasible based on three major criteria:

1. Effectiveness
2. Implementability
3. Cost

SELECT alternatives for implementation using one or more decision-making tools.

Step ⑤

Implement Projects

Schedule projects keeping in mind resources, time, and financial constraints.

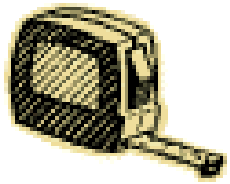
Assign responsibilities for who is going to do what and when.

TALK to the workers who will be affected by the changes you'll make. Include them in the implementation phase.

Stay in touch after implementation, get employee Feedback, and work out the bugs.

Step ⑥

Measure Progress



Track waste generation, material usage, and cost savings as a result of the changes you've made.

Use a method of measuring pollution prevention that takes into account variations in production level.

Document results.

Publicize and **CELEBRATE** your success!

Now **Go back to Step 2**. Keep the momentum going. There's more work to do.

1 Get Organized

"If you don't know where you're going, you'll end up somewhere else."
-- Yogi Berra

Get the boss on board.

Management can demonstrate a commitment to pollution prevention by launching a program with slogans, logos, and T-shirts or by distributing a simple memo. Either way, it's the meaningful support of management that is crucial to successful pollution prevention.

The people in charge can show they are serious about examining and if appropriate, modifying products or operations by:

- Establishing a pollution prevention **policy.**
- Allocating **time** and **money** to pollution prevention planning and implementation.
- Assigning **responsibilities** for tracking progress.
- Incorporating pollution prevention awareness into existing **training** programs for quality, compliance, or health and safety.
- Recognizing achievements through **awards** or bonuses.

Make it a team effort

Pollution prevention planning requires a variety of skills and access to different types of information. All employees have a role to play at some point in the process—gathering information, suggesting improvements, evaluating alternatives, or implementing projects. Get a team together to organize these planning activities. By going through the planning process, employees will gain a better understanding of the business and see the true consequences of "business as usual."

Who should be on the planning team?

The team should be made up of supervisors and workers from different parts of the company to provide a mix of insights, perspectives, and expertise.

Employees who are familiar with some of the following issues will be helpful:

- Purchasing/finance/accounting.
- Facility and production processes.
- Waste management operations.
- Quality control requirements.
- Environmental regulations.

How big should the team be?

It depends on the size of your company. In smaller companies, employees often have multiple responsibilities, and owners are also "workers." So, the team may consist of only two or three people. In larger companies, the team might include representatives from each department.

Indiana Bearing Products quality assurance manager, John Crafty, took on the role of pollution prevention planning team leader. He needed to organize a team, so he announced the pollution prevention planning project at the monthly safety meeting. Since John also had responsibilities for regulatory compliance and waste management, he needed people with expertise in other areas of the company for the planning team. First, he asked the purchasing manager to participate. Then, after posting a request for participation on the planning team, a couple of interested employees from the production line volunteered. John was now ready to assign responsibilities for reviewing company processes.

Worksheet: Forming a Planning Team

Use this worksheet to jot down ideas about potential planning team members, when the team could meet, and what the team could do to get employees interested and involved in the effort.

1. Our team should be made up of these employees who have...

- ✓ Familiarity with facility and production processes _____
- ✓ Familiarity with waste management operations _____
- ✓ Understanding of product quality control requirements _____
- ✓ Understanding of environmental regulations _____
- ✓ Good rapport with manager/owner _____
- ✓ Ability to communicate & interact well with other people _____
- ✓ Other qualities that would be helpful _____

2. Our team could meet regularly...
(e.g., over coffee in the morning? Before or after other meetings you attend together?)

_____

_____

_____

3. Our team could get employees interested in pollution prevention by...
(e.g., devising a contest for best pollution prevention ideas? Including pollution prevention in training programs?)

_____

_____

_____

_____

2 Analyze Your Processes

"The root of all pollution prevention lies in understanding the process."
author unknown

Understanding **where** and **why** wastes are generated and **how much** they really cost your business is a critical step to finding ways to improve efficiency and save money.

This second step in the planning process involves a systematic assessment of your current operations to see where you should direct your efforts. To analyze your operations…

❶ Map out the steps in each process.

▼

❷ Determine the **AMOUNTS** of raw materials used and waste generated.

▼

❸ Determine the **FULL COSTS** of raw materials used and waste generated.

▼

❹ Tour your facility and ask questions.

▼

❺ Target processes for pollution prevention.

▼

After step ❺ you'll be ready to identify alternatives for reducing wastes in the targeted processes.

❶ Map out the steps in each process.

Draw a "picture" showing the **inputs** and **outputs** of each step in the production process, from purchasing raw materials to shipping finished product. Inputs include raw materials, water, and energy. Outputs are products and wastes.

Wastes are any losses, including spills, leaks, evaporative losses, cooling water, cleaning rags, unusable raw materials, sludge, spent chemicals, heat loss, and defective products, anything not going into a useful product or by-product.

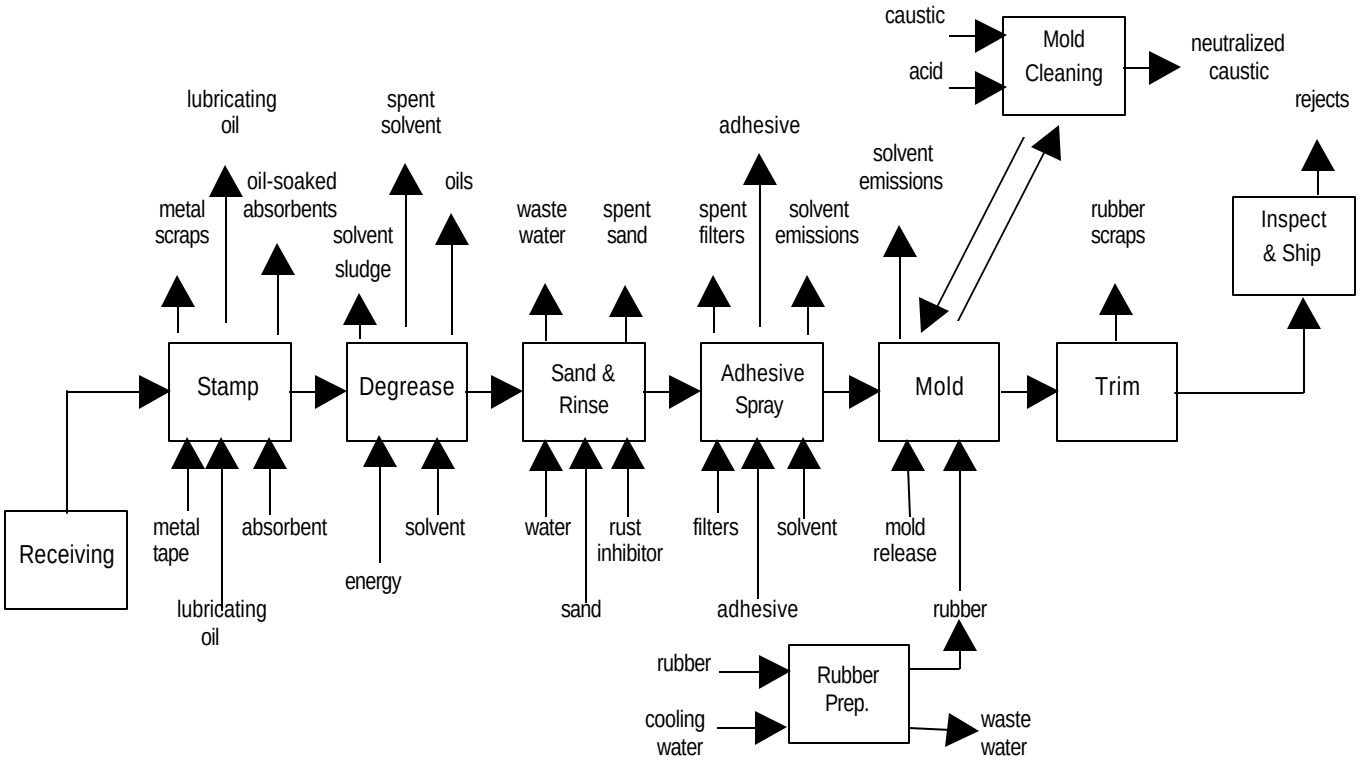
This type of picture, called a **process map**, is a useful tool because it:

- Offers a visual image that shows the relationship between different parts of the process.
- Provides the planning team with a common understanding of day to day operations.
- Pinpoints where your business generates waste.

Remember to show steps in your operation that are not directly part of the production process. These activities include intermittent operations (e.g., cleaning tank dumps, oil/fluid changes) and support functions (e.g., chemical storage, labs, wastewater treatment, boilers). Many cost-saving pollution prevention opportunities can be discovered here.

The next page shows a simplified process map for making ball bearings at Indiana Bearing Products.

Process Map for Making Ball Bearing Seals



The Indiana Bearing Products manufacturing process starts with the creation of metal washers. These are produced by feeding cold rolled steel ribbon into a **stamping** machine. Lubrication oil is applied by hand using a squeeze bottle. Waste oil is absorbed by clay absorbent and discarded as hazardous waste.

Following stamping, the washers are cleaned in a vapor **degreaser**, which uses trichloroethylene as the cleaning agent. After cleaning, the parts undergo a **surface preparation** step to allow a uniform coating of adhesive to be applied to the metal.

Adhesive is then applied using a standard spray gun. To do this, the parts are placed in a small wire mesh drum in a spray booth. As parts tumble in the drum, an operator sprays on the adhesive.

Overspray from the coating operation is captured by filters which are changed every few weeks.

After being sprayed with adhesive the parts are coated with rubber in heated presses. **Rubber is prepared** by heating and extrusion. The hot extruded rubber is cooled with municipal water.

Prior to **molding,** the dies are sprayed with a silicone-based mold release agent. The rubber and metal parts are then molded together. Because the mold release agent tends to build up on the dies, the dies must be routinely cleaned. A hot caustic bath is used. The caustic undergoes pH adjustment before being discharged to the sewer.

Following removal from the mold press, the parts are **inspected, packaged, and shipped.**

❷ Determine the AMOUNTS of raw materials used and wastes generated.

For each process, determine the annual amount of raw materials used and wastes generated. The reason for this step is to develop baseline data on your current operations. This information together with cost calculations will help you:

- **Prioritize** areas that need the most immediate attention.
- **Evaluate** proposed pollution prevention alternatives.
- **Measure** success after you have implemented a project.

Where to look for process information

Most of the necessary information may already be in the facility. Your purchasing or accounting department will probably have the information you need on annual purchase amounts. Look for waste information on manifests, permits, and environmental reports.

See Appendix B for more hints on where to look for process information.

❸ Determine the FULL COSTS of raw materials used and wastes generation.

First, figure out how much the raw materials cost for each process on an annual basis. Second, calculate what it costs to treat and dispose of each waste in the process. Third, identify the **"HIDDEN COSTS"** associated with compliance activities.

What are the "HIDDEN COSTS?"

The **FULL COST** of waste generation includes more than just treatment and disposal costs. You spend a lot of money complying with regulations for wastes your business generates. These environmental expenses are often referred to as hidden costs because they are usually assigned to overhead and not to processes responsible for them. Some of these costs are tough to track down, so using estimates is OK. Costs typically hidden in overhead include activities such as:

Reporting	Monitoring
Recordkeeping	Labeling
Permits & fees	Insurance
Pre-treatment equipment	Waste storage
Safety training	Manifesting
Protective equipment	Inspections

Waste disposal costs are often just a fraction of the full cost of generating the waste. Many pollution prevention projects will not appear to be justified if a company considers only a fraction of the likely savings.

Hidden Costs at Indiana Bearing Products

As business increased, so did the use of regulated materials and generation of waste. Indiana Bearing Products was on the verge of going from an Indiana small quantity generator to an Indiana large quantity generator (i.e., > 1000 Kg/month). The facility was also about to exceed air permitting and reporting thresholds. These are just some of the "hidden costs" they would incur if they continued business as usual:

- **$** Increased hazardous waste inspections, personnel training and reporting requirements.
- **$** Increased preparedness, prevention and emergency posting requirements.
- **$** Hazardous waste disposal fees.
- **$** Air permitting preparation, reporting and maintenance.

THESE REQUIREMENTS COULD ADD UP TO THOUSANDS OF DOLLARS!

❹ Tour your facility & ask questions

? ? ? ? ? ? ?

Walk through the facility to complete and verify your process maps. Talk to employees along the way to fill any gaps in information on material usage or waste generation. Doing so may be especially helpful for learning about intermittent and unplanned activities such as spills, clean-ups, and rinses. Staff responsible for monitoring, manifesting and other compliance activities will be able to help estimate hidden costs.

There are no dumb questions.

Let employees know why the team is conducting the facility assessment and ask for their input. **Ask** questions about why things are done the way they are even if the questions seem **dumb**. You may be surprised by the answer.

Here are a few key questions to get the team started:

1. Why is the process or chemical used?
2. What are the consequences of using this chemical or process;
   - ❖ on costs?
   - ❖ on worker health and safety?
   - ❖ on the environment?
   - ❖ on compliance requirements?
3. How can we make the process better?
   - ❖ What if we simply didn't use this chemical?
   - ❖ How can we use it more efficiently?
   - ❖ Can we substitute a safer chemical?

Make the Tour Efficient & Effective

See Appendix C to find…

- Tips for Touring the Facility
- 10 Questions to Think About During the Walk-Through

❺ Target Processes for pollution prevention.

Your team has found a number of areas that could use some help. Where do you start? Start by prioritizing pollution prevention opportunities. Consider issues important to your company, such as:

- ☞ regulatory compliance
- ☞ cost of raw materials and energy
- ☞ cost of waste management
- ☞ worker health and safety
- ☞ availability of cost-effective alternatives

Start with small projects if you have to, but just get started. Small improvements over the long-term yield **BIG** results in the end.

A picture says it all.

Small companies often need to prioritize opportunities based on cost. A good way to get management's attention is to illustrate the full cost of each waste stream on a pareto chart. You may have heard of the 80/20 rule – about 80 percent of your full costs are caused by 20 percent of your waste streams or activities. This chart makes the most costly waste streams readily apparent.

Targeting waste streams a and b would be a good starting point.

3 Identify Pollution Prevention Alternatives

"Nothing is more dangerous than an idea when it is the only one you have."
– Emile Chartier, Philospher

Are there any Detectives or Artists in the crowd?

At this point, your team has zeroed in on a problem you want to fix. The next step in your planning effort is to generate as complete a list as possible of pollution prevention alternatives to reduce those losses.

This section offers some methods to help generate pollution prevention ideas. First, get at the root cause of the problem. This may take a little detective work. Secondly, conduct a group brainstorming session to conjure up some creative possibilities. Seek employee input to come up with potential solutions too. Finally, consider looking to outside resources if you need help.

Get to the root of the problem.

Businesses generate wastes for a variety of reasons. Unnecessary purchases, outmoded processes, poor employee training and inadequate preventive maintenance often result in lost resources. Your task is to figure out what factors are responsible for creating waste.

Ask Why?

One way to identify the cause of a problem is to ask "why?" several times. Indiana Bearing Products received a compliance violation for exceeding discharge limits on copper. Therefore, reducing this waste was a **TOP PRIORITY.** They were considering purchasing ion exchange equipment to remove the copper before discharge. Fortunately, they first decided to ask WHY they had so much copper in their wastewater in the first place. It's a good example of how a company can avoid compliance problems through pollution prevention.

THE CASE OF THE MYSTERIOUS COPPER CONTAMINATION

Why do we have copper in our wastewater?
The mold cleaning bath has high levels of copper in it.

Why does the bath have high levels of copper in it?
Copper from the brass brush used to clean the molds is getting into the hot caustic cleaning bath.

Why does copper from the brush get into the bath?
Brushes remain in the bath between cleanings.

Why are the brushes left in the bath?
Line operators leave them there or drop them in and are unable to retrieve them.

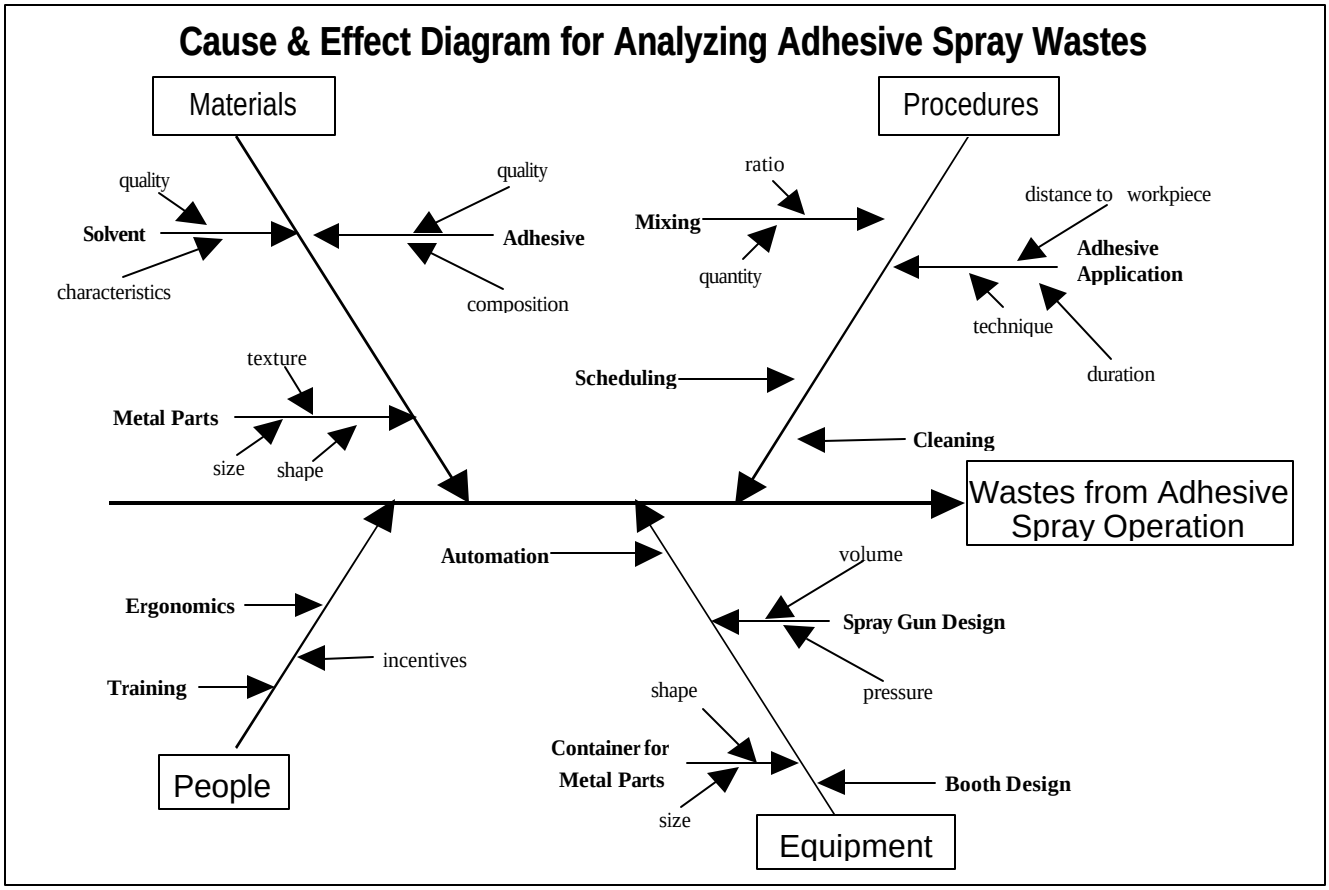
Molds are used to press the rubber and metal pieces of the ball bearing seal together. Molds are cleaned periodically using a brass brush in a hot caustic bath to remove mold release spray and rubber residue. Once the team realized that the copper was coming from the brushes, they tested alternative brushes. After having no success, the company created a separate brushing and rinsing station to avoid brushing over the caustic tank.

Indiana Bearing Products made a simple change, but it was not simply a "band-aid" solution. This simple change helped the company return to compliance without spending thousands of dollars on ion exchange equipment that still would have produced a hazardous waste.

Create a Cause and Effect Diagram

A cause and effect diagram is another tool that can help your team understand why a problem occurs or why a waste is generated. It provides a picture that shows everyone what factors affect a process and outlines possible causes of waste to explore in more detail. This type of diagram encourages people to look to many possible causes of a problem instead of simply acting on the first one they identify.

The planning team at Indiana Bearing Products put together the cause and effect diagram shown below to analyze losses from the adhesive spray operation. They targeted the adhesive spray process because solvent use and waste generation (and associated costs) were soaring. Furthermore, the level of solvent use was nearing a threshold that would have triggered the need for an air permit. And that would mean more paperwork and expenses.



The planning team went back to the adhesive spray process to examine the potential causes they had identified. The team found that the conventional spray equipment, application techniques and mixing procedures appeared to have the most significant effect on waste generation. With these major cause categories in mind, it was time for the team to do some **BRAINSTORMING** to come up with possible alternatives to the current process.

Think a Cause & Effect Diagram might help your company? Appendix D shows how to create one

Hold a **BRAINSTORMING** session

Once your detective work has led you to the most likely causes(s) of a particular problem or loss, hold a brainstorming session. Group brainstorming is an effective technique for generating ideas for solving the problem. It encourages spontaneous free flowing thought—the evaluation comes later.

The only way to have a good idea is to have many ideas.

BRAINSTORMING TIPS:

➢ Get a diverse group together. People who aren't directly involved with the targeted process can oftentimes ask the best questions, like why are we doing this in the first place?"

➢ State the problem clearly before you begin brainstorming so everyone is on the same page.

➢ Visit the work area. Make sure workers involved with the targeted process are in the brainstorming group.

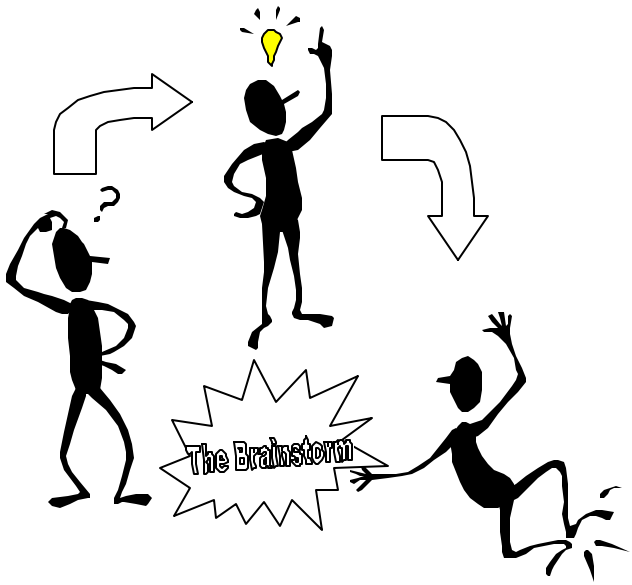
➢ Display the process map. This will help group members visualize changes and explain ideas to others. Look at the processes that occur before and after the step under consideration.

A few rules for the brainstorming exercise will keep creativity flowing and prevent negative thinking from influencing the team members.

Brainstorming Tips

- List every idea.
- No criticism of discussion.
- Conjure up outrageous alternatives.
- Stress quantity of alternatives, not quality.
- Build on alternatives posed by others.
- Have fun!!!

Of course, it is not always necessary to go through a formal process such as brainstorming to know what needs to be changed. If you already know what needs to be done, move on to the implementation phase. However, a typical mistake is to settle for an inadequately small list of alternatives to solve a problem. Keep in mind, the more alternatives you consider, the more likely you are to select the one that is best for your plant.



Consider a range of pollution prevention techniques.

Pollution prevention techniques fall along a continuum from fundamental change in products and processes to increased efficiency in what already exists. During your brainstorming session, consider the following six categories of **pollution prevention techniques:**

1 Product Reformulation

Can you reformulate your products to reduce the amount of toxicity of substance in it? For example, paint and ink manufacturers have reformulated products to eliminate heavy metals.

2 Input Substitution

Could any raw materials be replaced with less toxic substitutes? Many metal working firms have replaced chlorinated solvents with aqueous cleaners.

3 Process Redesign

Are there alternative ways of making your product that would cut raw material use or waste generation? Some printed wiring board manufacturers have switched to a direct metallization process for making through-holes conductive. This change eliminates use of formaldehyde and may reduce water and energy usage as well.

4 Process Modernization

Are there ways to modify or replace existing equipment that would cut raw material use or waste generation? Using an automated high volume, low pressure (HVLP) paint spray gun instead of a manual spray gun can reduce overspray.

5 Improved Operations & Maintenance

How can we reduce the needless waste of the materials we store, transport, handle and use? Examples include: computerizing inventory control, repairing leaks, installing overfill alarms and segregating wastes.

Appendix E contains a list of "Good Operating Practices" applicable to all industries.

6 Reuse and Recycling

Can any of our waste be recycled and/or reused, preferably without leaving the production process? One recycling technique involves installing a hard-piped solvent distillation unit capable of reclaiming spent solvents for reuse.

Brainstorming Results. The Indiana Bearing Products planning team got together with two adhesive spray operators to list possible ways to reduce losses from the adhesive spray process. This is what they came up with:

Brainstorming Session

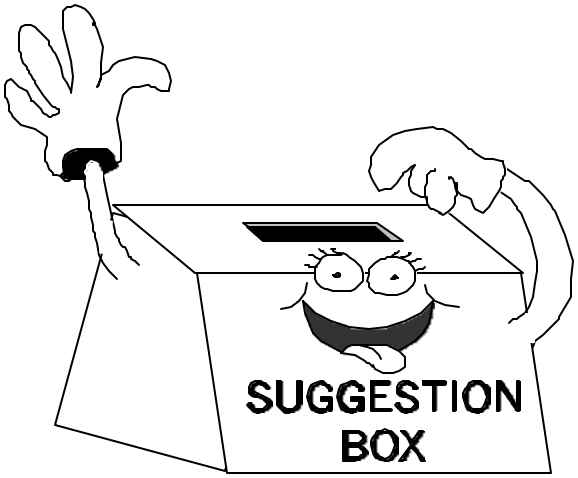
GOAL: Reduce adhesive spray wastes

- *Use washable filters, reuse solvent.*
- *Use solvent still to recover/reuse solvent.*
- *Use electrostatic charge to apply adhesive.*
- *Reuse gun cleaning solvent to thin adhesive.*
- *Switch to more efficient spray gun.*
- *Spray for shorter duration.*
- *Clean guns less frequently.*
- *Install spray gun washer unit.*
- *Dip parts rather that spray.*
- *Improve training for mixing and spraying.*

Once your team has a list of alternatives in hand, the next step is to evaluate which project(s) to implement.

Encourage employee participation.

In many cases, the people working on the shop floor already have ideas for reducing waste, but have never had the opportunity to express them. Develop an easy way for employees to make suggestions. Offer a bonus or other incentive for workers who come up with ideas that are used. Or, publicize your pollution prevention efforts with an event, like a facility-wide pollution prevention contest.



Seek outside help.

To supplement your lists of ideas, consider turning to external sources of pollution prevention information. Talk to vendors. Get in touch with your trade association or industry peers. Look in industry-specific journals and books. Attend workshops and industry trade shows.

Call one of the many technical assistance resources available to Indiana companies. These resources will provide your team with assurance that it has not overlooked simple proven techniques already used by other companies.

See Appendix A for a list of technical assistance resources.

4 Evaluate Alternatives

"Treating Pollution is an expense.
Preventing it is an investment."
-author unknown

Sounds good, but is it right for us?

Your team has generated a long list of pollution prevention alternatives for each targeted process. The next step is to determine which projects are feasible and prioritize them for implementation.

First, eliminate alternatives that are clearly unacceptable. Screen out any ideas that merely shift pollutants from one waste stream to another, or that treat or recycle waste after they have already left the process.

Alternatively, you might find that some ideas are so straightforward, inexpensive, and effective that no further assessment is needed in order to implement them. Make these cost-effective, low-tech pollution prevention changes first. These types of projects typically involve training and awareness, procedural changes, waste stream segregation, improved maintenance, and inventory control. Payback is often immediate. Move on to more capital-intensive alternatives as time and money permit.

Determine what's feasible.

Judge the advantage and disadvantages of the more complex alternatives based on three key criteria effectiveness, implementability, and cost.

1. Effectiveness

What is the alternative's potential for reducing losses from the process under consideration? For example, the proposed project may eliminate or reduce use of a hazardous material, or allow your company to recover valuable by-products.

2. Implementability

Will the alternative work for us? Your team will want to know how easy or difficult it will be to implement the project in terms of:

- System requirements and equipment reliability.
- Production and product quality issues.
- Worker acceptance and staffing needs.

Appendix F is a checklist your team can use to assess environmental, technical and personnel issues associated with proposed projects.

3. Cost

What will be the alternative cost? Will it be profitable? Realistically, the selection of a pollution prevention alternative will be heavily based on how it affects the bottom line. Every company has its own approach to the economic evaluation of capital investments, and each uses different criteria to justify these investments. Make sure your economic evaluation fits in with your company's approach.

Once again, be sure to consider how the proposed project affects environmental costs. Perhaps your project will reduce regulatory requirements or lower liability concerns. Standard cost analyses often overlook these sources of potential savings.

For more details on conducting an economic evaluation of pollution prevention projects, see Appendix G.

Keep a permanent record of the alternatives considered and your reasons for rejecting those you do not implement. This may help you avoid repeating this effort in future years.

For those alternatives you do want to implement, documenting the evaluation results will come in handy when it comes time to sell the project to management.

Select alternatives for implementation.

"Bubble up/Bubble down" is a neat trick for deciding among a large number of pollution prevention alternatives. First, the team lists the alternatives for a given process on a flip chart. Then, the group discusses the first two alternatives on the list to decide which of the two is **"**BETTER**"** in terms of effectiveness, implementability and cost. The better one "bubbles up" to the top of the list.

Next, the team looks to the next unique pair. If item ② bubbled up on the last round, the next unique pair would be ① and ③. If not, the next unique pair is ② and ③. As alternatives are added to the list, they become part of new pairs to be evaluated. For example, if the team decides that ⑥ is better than ⑤, it then asks whether it is also better than ④. If so, is it better than ③, and so on. When the alternative stalls, the team goes back down the list to find the next unique pair and the process continues. Feasible alternatives readily bubble up, while the not so good ones quickly bubble down.

Criteria Matrix

Another way to decide among pollution prevention alternatives is to use a criteria matrix. The first step is to list the alternatives down one side of a table. The team selects criteria to be considered and writes them across the top of the matrix. The matrix below uses effectiveness (E), implementability (I) and cost (C) as the criteria. Your team may choose to consider more specific criteria such as those used for targeting processes in the first place (e.g., compliance, health and safety, waste reduction, reduced costs, energy use).

Next, the team must agree on a scoring system, such as rating on a scale of 1 to 10 or 1 to 5. Some teams use a scale of +, -, 0. Finally, rate the alternatives and total the scores.

After eliminating alternatives that were clearly infeasible, the Indiana Bearing Company team used a criteria matrix to select alternatives for minimizing adhesive spray wastes. They used a five-point scale. Two alternatives received a score of **15**—switching to automated HVLP spray guns and reusing spray gun cleaning solvent to thin the next batch of adhesive. They also decided that training operators to mix the amount of adhesive appropriate for a given job more accurately (score of 13) was also worth a try—a no-cost way to reduce waste.

Indiana Bearing Products Criteria Matrix

Alternatives to reduce adhesive spray wastes

Alternative	E	I	C	Total
① use washable filters	2	3	4	9
② install solvent still	3	4	3	10
③ reuse gun cleaning solvent	5	5	5	15
④ use HVLP spray guns	5	5	5	15
⑤ paint gun washer unit	3	4	3	10
⑥ improve training	4	4	5	13
⑦ clean guns less frequently	2	5	5	12
⑧ spray for shorter duration	2	5	5	12

E=Effectiveness; I=Implementability; C=Cost

5 Implement Projects

"Try? There is no try. There is only do or not do."
Yoda, in *The Empire Strikes Back*

Schedule projects and set goals

Your team may find a pollution prevention alternative that would benefit your company for each of the targeted processes. The projects selected are both technically possible and profitable. However, few companies are able to invest immediately in every project that appears promising. Resource, time and capital constraints often make it necessary to set priorities and implement changes over time. So, schedule projects for implementation with these constraints in mind.

Implementation Schedule

Project	Start Date	Target Date	Goal	Leader
1				
2				
3				
4				
5				

Establish a timeline for each project and assign responsibilities for who is going to do what and when. Schedule simple investments first because they provide quick, money-saving results. Achieving obvious successes early on helps keep the momentum going.

Once your team knows what changes will be made, set goals for each pollution prevention project. Goals should be easily understood, easily measured, supported by the people they affect, and realistically achievable. A goal might be "25percent reduction in rubber scrap per part produced," or a goal may be to eliminate a cleaning operation all together. **Step ⑥: Measure Progress,** discusses how to evaluate performance.

Questions about Financing your Project?
The Office of Pollution Prevention & Technical Assistance can help. Refer to Appendix A.

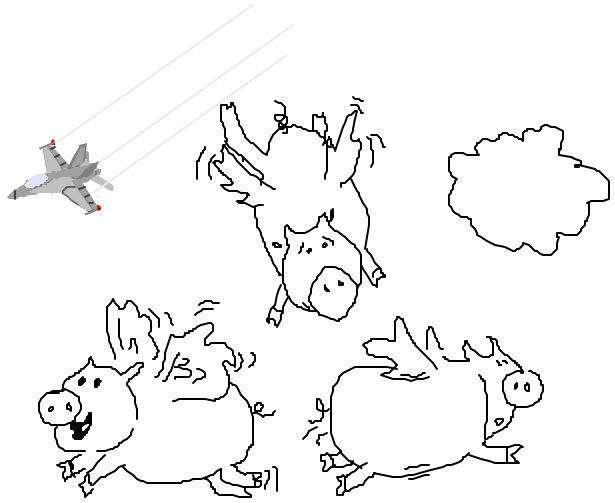
Tips for successful implementation

To ensure success your company will need to get the active cooperation of all employees. Indiana Bearing Products offers these 3 Tips to help make implementation go smoothly:

Tip #1: Involve Employees. Make sure the people who are affected are involved with implementing the change from the very start.

Tip #2: Provide Training. Provide the necessary training for workers to operate the new equipment and to use new procedures. Explain the environmental and financial advantages of the new way of doing things.

Tip #3: Stay In Touch. Implementation doesn't end with the installation of new equipment and/or new work practices. Encourage comments from all affected workers. Be prepared for fine tuning.



"...and they said it couldn't be done."

6 Measure Progress

"Not everything that can be counted, counts.
Not everything that counts, can be counted."
Albert Einstein

Is it Working?

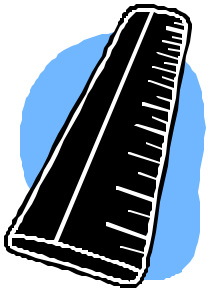
Tracking the progress of each project is critical to show that your investment was worth it and that material losses are being reduced. Documenting successes also sets the stage for additional pollution prevention. The best way to measure progress of your pollution prevention project is to:

❶ **Calculate cost savings.** Is the project meeting expected economic benefits (e.g., net operating cost savings, payback)? Compare actual savings to those projected in your economic evaluation in Step ④ of the planning process.

❷ **Calculate changes in waste generation of material use** as a result of the pollution prevention project. Use the materials accounting and waste generation information your team collected as part of Step ② in the planning process as the basis for comparison.

Account for production variations.

If quantities of waste or chemical use decrease after your company introduces a pollution prevention technique, the improvement might be attributed to the pollution prevention effort…or it might have happened because production decreased during that period. To get an **accurate measure** of losses prevented as a result of a pollution prevention project, correct for changes in production rate. One way to do this is by measuring material use or waste generation per **unit-of-product.**



Selecting a unit-of-product

A unit-of-product is a measure that reflects the level of production or activity associated with the use of a material or generation of a waste. For some firms this will be as easy as keeping track of the amount of product produced annually (e.g., a chair manufacturer could use the number of chairs.) For other facilities, this might not be a simple issue. Other measures of production levels should be used, such as pounds, square feet, or gallons of product manufactured.

Examples of Unit-of-Product Used by Different Industries

Industry	Unit-of-Product
metal finishing	ft^2 of substrate plated or coated
paper recycling	tons of paper produced
electronics	# of passes substrate makes through process
pharmaceutical	kilogram of product produced

Indiana Bearing Products had several choices for its unit-of-product, including:

- Number of finished products made.
- Mass of metal produced.
- Surface area of metal processed.

Number of products was rejected because it fails to account for the wide range of sizes and shapes of the products, which affects the amount of chemicals used**. Mass of metal produced** was eliminated because it was not directly related to the amount of material used or waste generated in the adhesive spray process.

Surface area of metal processes was chosen as the unit-of-product because it is directly related to material use and waste generation in the adhesive spray operation.

The Indiana Bearing Products team measured the success of their new automated HVLP system for applying adhesive. To measure the percent reduction in solvent use while adjusting for increased production, they used this formula:

$$\text{Percent Reduction (\%)} = \frac{(A - B) \times 100}{A}$$

$$A = \frac{\text{annual solvent use BEFORE project}}{\text{unit-of-product}}$$

$$B = \frac{\text{annual solvent use AFTER project}}{\text{unit-of-product}}$$

The company used 1,800 gallons of solvent during a year when they processed 325,000 ft^2 of metal. After the new system was implemented, they used only 660 gallons of solvent while INCREASING to an annual production rate of 500,000 ft^2 metal processed.

$$\text{\% Reduction} = \frac{(1800 \text{ gal.}/325{,}000 \text{ ft}^2) - (660 \text{ gal.}/500{,}000 \text{ ft}^2)}{1800 \text{ gal.}/325{,}000 \text{ ft}^2} \times 100$$

= 76% Reduction!

By implementing this pollution prevention project, Indiana Bearing Products achieved:

- **A 76% reduction in solvent use per ft^2** of metal processed compared to what they would have used with their previous spray system.
- **Annual savings of $24,000** as a result of decreased costs in:

Waste disposal	$6000
Solvent purchases	$18,000

- **Avoided regulatory costs** (potentially thousands of dollars) they would have incurred had they continued to use solvent and generate waste at their previous rate.

Does your company submit an Annual Toxic Release Inventory Report to the Indiana Department of Environmental Management? Measuring progress using the method shown here will put you in a good position to answer questions about your company's waste reduction efforts.

Publicize success stories

Early successes can help build enthusiasm for pollution prevention among workers and management---perhaps making it easier to gain approval and funding for future pollution prevention changes. So, document the results of your projects and let everyone know how these changes are working out.

Appendix H contains a sample form for documenting pollution prevention progress.

Here are some other ways to highlight achievements…

- Recognize the efforts of individuals who provided suggestions that were implemented. Cash awards wouldn't be a bad idea.
- Use a newsletter, memo, or bulletin board to highlight project savings, waste reductions, energy savings and product quality improvements resulting from pollution prevention projects.
- Grab some positive media attention by putting together a news release for local newspapers. Emphasize benefits for the company and for the surrounding community.
- Apply for the Indiana Governor's Awards and get the recognition you deserve.

See Appendix I for more information about the Governor's awards.

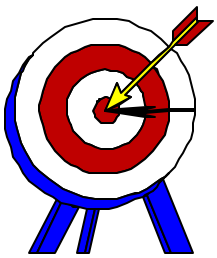
Next Steps...

Planning for the Future

"The trouble with our times is that the future is not what it used to be."
Paul Valery

Repeat the planning Process.

If pollution prevention is to take root and prove genuinely successful in your facility, make sure your pollution prevention team doesn't whither after it has made a few improvements. Repeat the steps outlined in this guide to search for new pollution prevention opportunities. Update process maps and revisit your list of opportunities on a scheduled basis. Develop more accurate data on material use and waste generation. Select new targets for pollution prevention efforts.



Remember that pollution prevention alternatives take shape against the backdrop of pending regulations, shifting costs of raw materials and disposal, and changing public concerns and customer demands. Being aware of these changes can help you identify new pollution prevention opportunities or make a case for changes that might previously have been unattractive.

Integrate pollution prevention into business practices.

Each successful pollution prevention experience provides incentive for management to support and diversify pollution prevention within your company. With time, pollution prevention can become a natural part of the company's infrastructure and operating practices. For example, as your company develops new processes or products, you may consider how to design them with pollution prevention in mind.

The Quality Connection

If your company has embraced the principles of **TOTAL QUALITY MANAGEMENT (TQM)**, you will recognize that pollution prevention and TQM share central beliefs. Like TQM, pollution prevention requires the active and sustained commitment of a wide range of personnel: from top management, to purchasers, to research and development personnel, to production line workers. Both programs also call for continuous incremental improvements, each of which moves your firm closer to the ultimate goal of best possible quality or of least possible losses. Use your quality management system to integrate and sustain pollution prevention efforts.

Environmental Management Systems

Is your company ready to take environmental management a step further? Pollution prevention planning provides a foundation for developing an **environmental management system (EMS).** An EMS is a more formal and comprehensive way to review and improve operations for better environmental performance. An EMS can cover pollution prevention, energy use, natural resource issues, regulatory compliance, emergency planning, communication with interested parties and other environmentally-related issues. With an EMS environmental issues can become integrated into all facility operations.

Every company can benefit from an EMS, regardless of whether the facility chooses to pursue ISO 14000 certification. (ISO 14000 is the international standard for environmental management, much like ISO 9000 is the standard for quality management.) An EMS can help your company meet business and environmental goals.

APPENDICES

Appendix A

Technical Assistance Resources

INDIANA OFFICE OF POLLUTION PREVENTION AND TECHNICAL ASSISTANCE

Pollution Prevention (P2)	Source Reduction & Recycling	Compliance & Technical Assistance Program	Toxic Release Inventory (TRI)
Promotes pollution prevention within industry, IDEM and other state agencies. Works with Clean Manufacturing Technology Board, Partners for Pollution Prevention and Clean Manufacturing Technology and Safe Materials Institute (CMTI)	Encourages and facilitates source reduction and recycling activities throughout the state. Works with local solid waste districts, Indiana Recycling Coalition and Solid Waste Planning Advisory Council.	Provides compliance assistance to businesses and communities. Works with other departments in IDEM, business and industry groups, citizens, and the Compliance Advisory Panel. Manages recognition programs for various industry sectors.	Maintains the Form R's submitted by Indiana manufacturers and analyzes submitted data for accuracy and trend analysis. Information is utilized to promote pollution prevention, and to measure pollution prevention release reduction progress in the state.

What OPPTA Offers

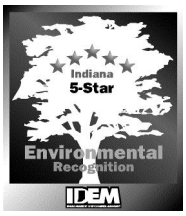
Grants:

- Source reduction and recycling grants – primarily for local units of government and nonprofit organizations.
- Household hazardous waste grants for ongoing collection and education programs for local units of government.
- Pollution prevention grants – open to almost all organizations, businesses, or governments to support innovative P2 technologies. P2 grants are available only in special offerings for priority projects or industries. Recent examples are publicly-owned treatment works and environmental management systems (ISO 14000) development.

  P2 grants are offered on an irregular basis, interested parties should stay in regular contact with OPPTA to keep abreast of availability.

Recognition:

- Governor's Award for Excellence in Pollution Prevention
- Governor's Award for Excellence in Recycling
- Governor's Toxics Reduction Challenge
- Partners for P2
- 5-Star Recognition Program to recognize environmentally sound practices and leadership in specific industries:
  - Childcare
  - Drycleaning
  - Vehicle Maintenance
  - Metal Finishers



Outreach:

- Comprehensive compliance manuals and workshops for those industries with a 5-Star recognition program, and the fiberglass, wood furniture manufacturing, and printing industries.
- Mercury education and recycling program for heating, ventilation and air conditioning industry, hospitals and solid waste districts, including statewide collections for homeowners and small businesses.
- IDEM's initiative focusing on protecting children from the harmful effects of lead, mercury, pesticides and other environmental hazards.
- Materials Exchange – a marketplace listing of available by-products and surplus materials.
- Annual Pollution Prevention Conference and Trade Show.

Assistance:

- Phone assistance for those seeking **confidential help** or who have been unable to find the proper contact in other areas of the agency.
- On-site compliance and technical assistance to address site specific issues.
- Annual Workshops highlighting general procedures and changes in Toxics Release Inventory (Form R) requirements.

A legally binding confidentiality mandate (IC 13-28-3-4) insures that compliance assistance inquiries to Compliance & Technical Assistance Program (CTAP) staff will not be revealed to regulatory staff or the public.

Appendix A (continued)

Technical Assistance Resources (continued)

INDIANA OFFICE OF POLLUTION PREVENTION AND TECHNICAL ASSISTANCE

HOW TO REACH OPPTA STAFF

Indianapolis
(317) 232-8172 or
1-800-988-7901

Northern Indiana
(South Bend area)
(219) 245-4879

Northwest Indiana
(Lake, Porter Co. area)
(219) 881-6720

Southwest Indiana
(Evansville area)
(812) 436-2583

Southern Indiana
(Clark, Floyd Co. area)
(812) 952-1144

MAIN OFFICE

Assistant Commissioner Office of Pollution Prevention & Technical Assistance	317-232-6658
Branch Chief, Pollution Prevention (P2)	317-233-6661
Branch Chief, Compliance & Technical Assistance Program (CTAP)	317-233-6663
Branch Chief, Operations	317-233-5624
Branch Chief, Source Reduction & Recycling	317-233-5431

Indiana Department of Environmental Management
Office of Pollution Prevention & Technical Assistance
150 West Market Street, Suite 703
Indianapolis, Indiana 46204

For more detailed information on OPPTA, visit our website:
www.IN.gov/idem/oppta/index.html

BUREAU OF SAFETY EDUCATION AND TRAINING (BUSET)

The consultation program helps businesses identify, evaluate and correct workplace hazards.
Services include:

- On-site assistance
- Assessment of safety and health programs
- Regulatory research
- Workshops,10 and 30 hour training classes
- Free compliance programs and training materials

Contact:: Deputy Commissioner,
Bureau of Safety Education and Training
402 W. Washington Street, Room W195
Indianapolis, IN 46204
317/232-2688 FAX 317/233-1868

For more detailed information on BUSET, visit their website: www.IN.gov\labor

Appendix A (continued)

Technical Assistance Resources (continued)

INDIANA CLEAN MANUFACTURING TECHNOLOGY AND SAFE MATERIALS INSTITUTE (CMTI)

Strengthening Indiana's economic development by promoting clean manufacturing technology.

Clean Manufacturing as Defined by the State of Indiana

"Clean Manufacturing" means the employment by a manufacturer of a practice that: (1) reduces the manufacturing use of toxic materials; or (2) reduces the environmental and health hazards associated with an environmental waste without diluting or concentrating the waste before the: recycling, release, handling, storage, transport, treatment, or disposal of the waste. The term includes changes in production technology, materials, processes, operations, or procedures.

The term does not include a practice that is applied to an environmental waste after the waste is generated or comes into existence or after the waste exits a production or commercial operation.

Focus of CMTI

Operated by Purdue University, the Institute currently focuses on four priority manufacturing sectors:

- Wood products manufacturing,
- Plastics, including recreational vehicle manufacturing,
- Metal plating and coating, and
- Motor vehicle parts manufacturing.

Functions of the CMTI

There are several basic functions of the Institute established by state statue:

- Coordination/Cooperation with other public and private colleges and universities
- Technical Assistance Services
- Conduct Research
- Curriculum Development and Training
- Policy Analysis
- Measurement of Pollution Prevention Progress
- Development of Clean Manufacturing Plans

Contact CMTI

Indiana Clean Manufacturing
Technology and Safe Materials Institute
2655 Yeager Road, Suite 103
West Lafayette, IN 47906
Phone: 765/463-4749
Fax: 765/463-3795

For more detailed information on CMTI visit them on the Web at: www.ecn.purdue.edu/CMTI/

Appendix A (continued)

Technical Assistance Resources (continued)

Internet P2 Resources List

Indiana Based P2 Resources:	
IDEM Office of Pollution Prevention and Technical Assistance:	www.IN.gov/idem/oppta
Indiana Clean Manufacturing Technology and Safe Materials Institute:	http://www.ecn.purdue.edu/CMTI
National Resources:	
USEPA P2 Program:	http://www.epa.gov/opptintr/index.html
National Pollution Prevention Roundtable (industry resources):	http://www.p2.org/indp2/indp2.html
USEPA Envirosense:	http://es.epa.gov
P2 Gems:	http://p2gems.org
Regional Based Resources:	
Great Lakes Regional Pollution Prevention Roundtable (P2 Resources Exchange/P2RX):	http://www.p2rx.org
Good State P2 Websites:	
Kentucky Pollution Prevention Center:	http://www.kppc.org
New Hampshire P2 Program:	http://www.des.state.nh.us/nhppp
Toxic Use Reduction Institute:	http://www.turi.org
Commercial P2 Websites:	
Cleaner Production:	http://www.cleanerproduction.com

APPENDIX B

Where to look for Process Information

1. Environmental Records
   - SARA 313 Form R
   - Hazardous waste manifests and annual reports
   - POTW or NPDES permits
   - Air emissions monitoring records
   - Laboratory waste analysis and flow measurements
2. Process Schematics
   - Facility blueprints
   - Schematics of storage, processing and shipping areas
   - Piping diagrams
   - Process maps or other process descriptions
   - Equipment lists
3. Technical Data on Substances and Processes
   - Material Safety Data Sheets (MSDS)
   - Maintenance procedures and records
   - Production line scheduling records
   - Production line job sheets, batch make-up records and mix tickets
   - Equipment operating manuals
4. Technical Data on Products
   - Customer specification
   - Quality control records
   - Product data sheets
5. Other Business Operations Records
   - Chemical inventory records
   - Chemical purchasing data
   - Product sales records
   - Waste transporter invoices
   - Scrap sales and recycling records
   - Organizational charts
6. Financial Records
   - Department cost accounting reports
   - Treatment and disposal cost records
   - Chemical purchasing cost records

APPENDIX C

Tips for Touring the Facility

- Schedule the tour and publicize it in advance.
- Let workers know why you are doing this; ask for suggestions for improvement.
- Examine intermittent operations such as maintenance procedures.
- Cover all areas where materials are used or processed.
- Follow the path the materials take, from the receiving dock, along the process flow, and ending with the product storage and shipping areas, as well as waste treatment or storage areas.
- Check the actual process against the process maps your team has created.
- Ask why things are done in a particular way. Remember, there are no dumb questions.

10 Questions to Think About During the Walk-Through

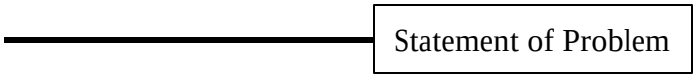
1. Does our facility show signs of poor housekeeping (e.g., cluttered walkways, unswept floors, uncovered drums)?
2. Where do we notice waste being generated from processes in our facility (e.g., dripping water or steam, leaks, spills, evaporation, drag-out)?
3. Is there discoloration or corrosion on walls, work surfaces, ceiling and walls or pipes? This may indicate system leaks or poorly maintained equipment.
4. Where do we see smoke, dirt, or fumes to indicate material losses?
5. Do we smell strange odors, or experience eye, nose or throat irritation when we first enter the workplace? These symptoms might indicate system leaks, etc.
6. Are there open containers, stacked drums, shelving too small to properly handle inventory, or other indicators of poor storage procedures?
7. Are all containers labeled as to their contents and hazards?
8. Is emergency equipment (fire extinguishers, spill kits, phones) available and visible to ensure rapid response to a fire, spill, or other incident?
9. Is scrap, or off-specification parts lying around?
10. Check inventory. Is any out dated stock, or materials still in storage that we no longer use? Is stock managed by “First in-First out” procedures?

APPENDIX D

How to Make a Cause & Effect Diagram

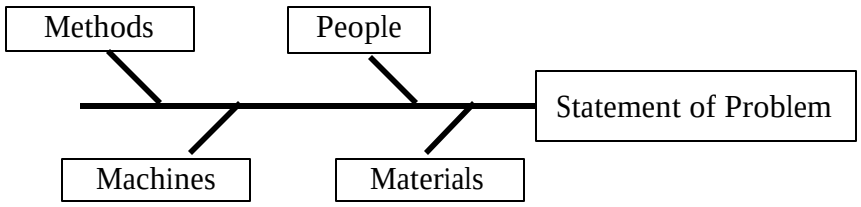
[Adapted form Pojasek, R. B. (1996) "Using Cause and Effect Diagrams in Your P2 Program." Pollution Prevention Review 6(3):99-105]

A cause and effect diagram is a valuable problem-solving tool for gathering information on common pollution prevention problems, such as losses of raw materials or hazardous constituents from a manufacturing process. To construct the diagram, draw a horizontal line with a box on the right hand side. In the box write the loss that the team has selected to focus on. It is useful to think of the loss or waste as the effect and some aspect of the production process or operation as the cause.



Cause Categories

Four basic cause categories are typically used: **people, methods, machines, and materials**. Other cause categories may be added (e.g., measurement, surroundings, policies). Cause categories are palced in boxes at the end of diagonal lines radiating out from the horizontal line:



Think about what each of these categories means:

- **People** includes all workers and managers, plus factors such as their knowledge, training, certification capabilities, and attitudes.
- **Methods** focuses on issues such as process work flow, work procedures, and standard operating procedures.
- **Machines** includes all machinery, equipment, and instrument controls, as well as factors such as adjustments, maintenance, and tooling capability.
- **Materials** include all expendable inputs to the process and their characteristics, such as supplies, changes, and variability.

APPENDIX D (continued)

How to Make a Cause & Effect Diagram (continued)

Working through the Cause and Effect Diagram

The team can start with any major cause category to identify potential causes for the loss or waste. For example, they might start with "people." They could ask questions such as:

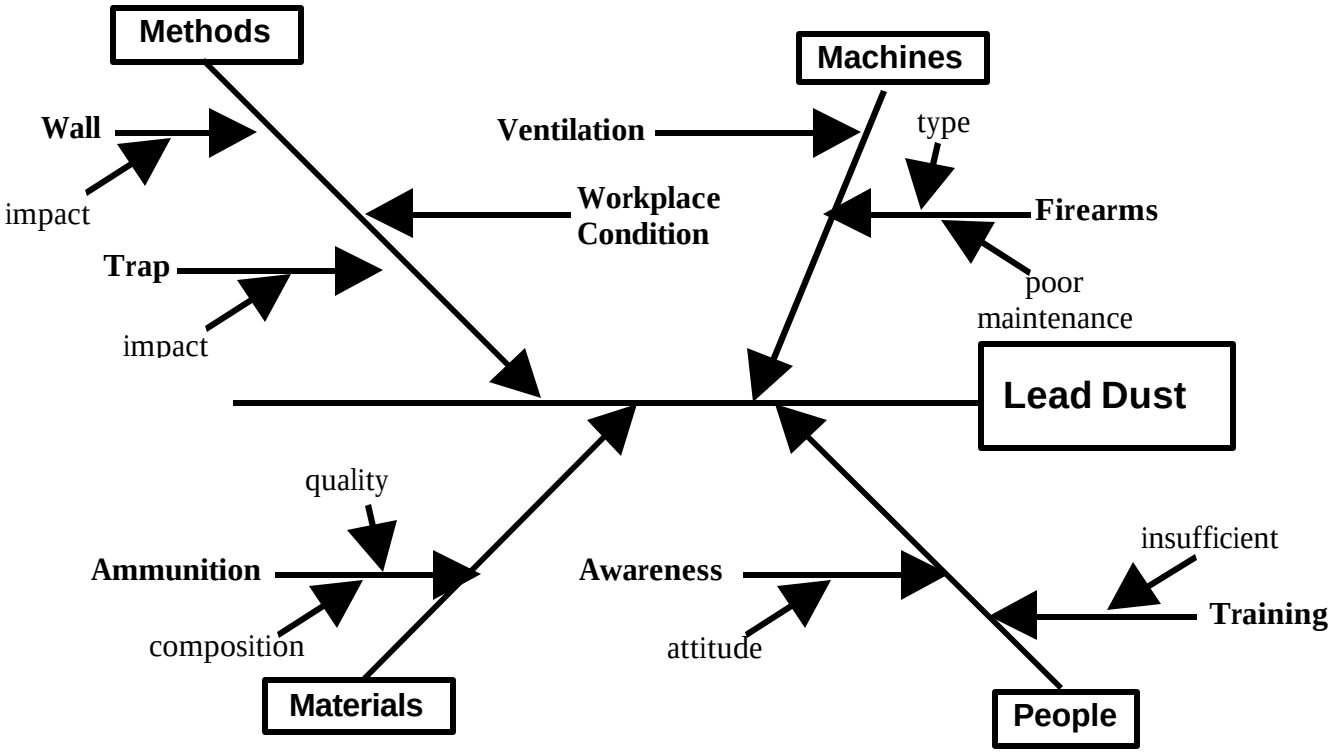
- What are people doing that causes the loss to exist?
- Why are people doing what they are doing?
- Who are the people involved (i.e., what job classification)?
- When are people causing this loss?

Enter the answers to all the questions on the diagram, then move on to another cause category. Repeating sub-causes in several places is acceptable if the team feels there is a direct relationship. This effort will ensure that the team creates a complete diagram and fully understands the issues. If questions are slow in coming, use the major cause categories as catalysts. For example, "What in our methods is causing…?" or "What in our materials is causing…?"

Refining the Analysis

When the initial effort is complete, the team should review each major category. Look for cause that appear in more than one category. This is an indication of a "most likely cause." You can also poll the team members or estimate the percentage that a given cause contributes to the problem in order to come up with additional "most likely" causes. Circle these causes on the diagram. Next, review the most likely causes and ask: Why is this a cause? Asking the "why" question will help you get to the root cause of the problem. Show the diagram to a few other people to get their opinion. Consider posting it in an accessible location and allowing many people to get involved in working on and understanding the process. The completed cause and effect diagram can then help a team to prepare to "brainstorm" a variety of alternatives for addressing the loss.

Cause and Effect Diagram for Lead Dust Problem in an Indoor Firing Range



APPENDIX E

Good Operating Practices

Employee Awareness and Education

Provide training for:

- Operation of the equipment to minimize energy use and material waste
- Proper materials handling to reduce waste and spills
- Importance of pollution prevention in terms of economic and environmental ramification

Purchasing

- Use "just in time" ordering system
- Establish centralized purchasing programs; track and record chemical purchases
- Order reagent chemicals in exact amounts
- Encourage chemical suppliers to become responsible partners (e.g., accept outdated materials)
- Review material procurement specifications
- Avoid collecting free samples of process chemicals from vendors—only accept amounts needed for testing purposes

Storage

- Utilize a dedicated/protected storage area
- Space containers in storage areas to facilitate inspection
- Label all containers
- Stack containers according to manufacturer's instruction to prevent cracking and tearing
- Separate incompatible materials in storage such as cyanides and acids
- Raise containers off the floor in storage area to inhibit corrosion from "sweating" concrete

Handling/Use

- Track material use
- Pre-inspect parts to prevent processing of obvious rejects or pre-cleaning of "clean" parts
- Establish written procedures for process formulation and additions
- Use a minimum of non-hazardous materials (e.g. absorbent, water) to clean up hazardous spills
- Use process baths to the maximum extent possible
- Implement Statistical Process Control to improve efficiency of chemical use
- Eliminate obsolete processes and/or unused or infrequently used processes
- Reuse cleanup solvent
- Use mechanical wipers on mixing tanks
- Use a cleaning system that avoids or minimizes solvents; clean only when needed

Preventive Maintenance

- Maintain equipment history cards on equipment location, characteristics, and maintenance
- Maintain master preventive maintenance schedule
- Keep vendor maintenance manuals handy
- Maintain a manual or computerized repair history file

Waste Segregation

- Prevent mixing of hazardous waste with non-hazardous wastes
- Store material in compatible groups
- Include careful labeling to ensure identification of wastes which have the potential for recycling or resale

Leak/Spill Prevention and Control

- Employ a controlled method of adding makeup water to process tanks
- Install overflow alarms on all process tanks
- Construct secondary containment with segregation that would permit reuse of spilled material
- Prevent/contain spills and leaks by installing drip trays and splash guards around processing equipment

APPENDIX F

Feasibility Checklist for Pollution Prevention Alternatives

Pollution Prevention Alternative: _____

Issues to Consider	Comments
Equipment	
① Does this option have a proven track record?	
② Will the vendor guarantee this system?	
③ Are materials and parts readily available?	
④ Can the system be easily serviced?	
⑤ Is there vendor support available for start-up, testing?	
⑥ Does the system require new utilities?	
Environmental	
① Will this option create less waste or decrease the use of toxic substances?	
② Could this option shift pollutants from one environmental medium to another?	
③ Will new permits be required?	
Production and production	
① Will this alternative adversely affect productivity?	
② Will this alternative adversely affect product quality?	
③ Can the equipment fit in existing space?	
④ Will installation stop production? How long?	
Employees	
① Will this alternative require additional staff?	
② Does the alternative alleviate or create health and safety problems?	
③ Will additional training be required for this option?	
④ Will worker acceptance be an issue?	
⑤ Will the alternative help reduce regulatory paperwork?	

APPENDIX G

Economic Analysis of Pollution Prevention Projects

An economic analysis of a pollution prevention project will assist a company in determining if that particular investment will add economic value to the company. This value can be assessed by calculating cash flows over the life of the project and applying measures of profitability. However, many of the costs and potential savings of pollution prevention projects are not included or are underestimated in conventional financial analysis.

Traditional cost categories include direct materials, direct labor, and overhead. Many indirect costs may be hidden in the overhead category and traditional financial analysis may underestimate the potential savings from a pollution prevention project. Also, conventional cost accounting might not evaluate the project over a sufficiently long time period and usually does not consider numerous important qualitative issues, possibly causing the pollution prevention project to be rejected.

What can you do to try to overcome some of these obstacles and to determine the true costs and savings of a pollution prevention project? This summary can help by covering the basic financial evaluation of a pollution prevention project, including the following steps:

❶ Collect cost information on current process costs and proposed project costs.

❷ Apply measures of profitability

❸ Consider less tangible costs

Try this analysis on one small project first to see how it might work, or try portions of the analysis as your time and resources allow. Use the **WORKSHEET** at the end of Appendix G to gather cost information.

❶ Collect cost information.

The first phase of the financial analysis of a pollution prevention project entails gathering complete and accurate data for costs that have a material impact on the decision and that are useful to those who evaluate the project proposal. All costs should be converted to total annual amounts in order to perform the financial analysis with common metrics. The following procedures can be used to determine these costs.

A. Use the cost information your team gathered as part of Step 2 in this planning guide for all the labor activities, materials equipment and other operating expense items that are involved in the targeted production process and secondary processes. Be aware of costs related to the tracking, treatment and disposal of waste, and those related to purchasing, handling and using hazardous chemicals.

B. Identify all the places where labor activities, material, equipment and other operating costs are likely to change.

C. Determine the costs in the current process and in the proposed project for those activities and items that will change because of the proposed project.

D. Calculate the differences between the current and proposed processes. Be sure to express the costs in after-tax amounts. For example, depreciation of equipment will reduce the taxable income of a company.

APPENDIX G (continued)

Economic Analysis of Pollution Prevention Projects (continued)

❷ Apply measures of profitability.

A measure of profitability is a single number that is calculated to characterize project profitability in a concise, understandable form. There are three common methods, or measures of profitability, used to assist the decision makers in a financial analysis to determine if a pollution prevention project will add economic value to a company. These measures include:

1 -- Payback period

2 -- Net Present Value (NPV)

3 -- Internal Rate of Return (IRR)

Each method is briefly explained here, including appropriate uses, advantages, and limitations. If you do not have a background in financial analysis or feel you do not have time to perform numerous calculations, don't despair! There are numerous spreadsheets and relatively straightforward computer programs that can do most of the work for you. If you have identified and collected cost and savings information, you have already done much of the work.

For example, you can download "P2/FINANCE" from EPA's Website. This is a spreadsheet system for conducting financial evaluations of current and potential investments. P2/FINANCE differs from conventional capital budgeting tools because it addresses traditional obstacles to the financial justification of pollution prevention investments. It runs with either Lotus 1-2-3 Version 3.4a for DOS or Microsoft Excel Version 5.0 for Windows. (EPA 742-C-96-001/002).

P2/FINANCE web address: http://www.epa.gov/opptintr/acctg/download/p2finan.html

Payback period analysis (simple payback) measures how long a period will take to return its original investment and ranks projects according to the length of the period: the shorter the period, the more attractive the project. The payback period is the amount of time required for an investment to generate enough cash flow to just cover the initial capital outlay for that investment. Depending on the nature of the cash flows, payback period can be calculated as follows:

If annual cash flows are equal, the initial investment amount is divided by the annual cash flow. For example, if the initial investment is $12,000 and the first year annual cash flow is $15,000, then the payback period is 13,000/15,000-0.8 years.

If the first year cash flow is greater that the initial investment, the initial investment amount is divided by the first year cash flow. If cash flows vary, and the initial investment is greater that the first year cash flow, succeeding years' cash flows are added incrementally until they equal the initial investment amount.

Payback period analysis has two drawbacks: it ignores the time value of money, and it ignores cash flows that occur after the initial investment has been recouped and does not show costs and savings past the point where the project has paid for itself. A chart that tracks the percentage payback of all cash flows over the life of the project may increase the payback method's usefulness.

Payback analysis provides a useful preliminary assessment of a project's attractiveness. If the payback is very short and the project is relatively simple, payback period analysis may be sufficient. However, this initial assessment should be verified by a Net Present Value analysis.

Net Present Value (NPV) analysis relies heavily on the concept of the time value of money and is the most powerful tool for assessing profitability over the life of a project. The time value of money recognizes that receiving $100 today is not equivalent to receiving $100 at some point in the future, because the $100 today can be invested to earn a return. Net Present Value is the present value of the future cash flows of an investment, minus the investments current cost.

APPENDIX G (continued)

Economic Analysis of Pollution Prevention Projects (continued)

The time value of money measures the value of money at different points in time as determined by a discount rate. The discount rate is the interest rate that is used to relate the future value of the money to the present value of the money. The discount rate is the rate of interest or return that a business or person can earn on the best alternative use of the money at the same level of risk. The discount rate is a function of what that company must pay to acquire capital (money) and what rate of return for a given level of risk it must earn on the investment to satisfy management and shareholders. Note that discount rates are not inflation rates, although they usually incorporate the projected rate of inflation. An example of how Net Present Value (NPV) can be calculated is shown below.

Net Present Value (NPV) analysis should be used when initially evaluating major pollution prevention projects and for the final analysis of most projects. Advantages of Net Present Value (NPV) analysis are it considers the time value of money and it measures the risk-adjusted value added to the company. Disadvantages include that it is more information and calculation intensive, requires the estimation of cash flows over the life of the project and requires the calculation of a discount rate.

NET PRESENT VALUE CALCULATION

Present Value of an investment

What is the value of future cash flows today? For example, what amount of money invested now at 10% will equal $130 in two years?

$$PV = FV / (1 + r)^{T}$$

$$PV = \$130 / (1 + 0.1)^{2}$$

$$PV = \$130 / 1.21$$

$$PV = \$107.44$$

PV-Present value, the value of the money received today (PV=$107.44)
FV=Value that will be received in the future, when invested (FV=$130)
R=The rate at which funds received today could be invested (R=10%)
T=The number of time periods in which interest is earned (T=2)

Receiving $130 in two years is equivalent to receiving $107.44 today and investing it for two years at 10%.

Net Present Value Analysis

Net Present Value (NPV) analysis compares the PV of the cash inflows to the initial investment. How do these present values related to the initial cash outlays? For example, in the present value analysis above, we could ask whether a projected income of $130 in two years is worth an initial investment of $100. To determine if this is a worthwhile investment, we subtract the initial investment from the PV of the cash received in year 2, as shown here.

NPV=PV (cash inflows) – PV (cash outflows)
NPV=$107.44-$100
NPV=$7.44

The NPV indicates how much extra return a project generates above the percent that is required by a firm's owners or managers. In this example, the investment generates $7.44 in excess of the 10 percent return that is required.

- If NPV is greater than zero, the project should be accepted.
- If NPV is less than zero, the project should be rejected
- If NPV equals zero, the project generates exactly the return that is required

APPENDIX G (continued)

Economic Analysis of Pollution Prevention Projects (continued)

NPV can be calculated for investment that covers different time periods. Present Value tables are also available that calculate PV factors for different rates and years. Refer to the document, *Improving Your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects* (NEWMOA/OTA, 1994) for more information.

Internal Rate of Return (IRR) is a profitability measure, expressed in percentage terms, that is analogous to an average rate of return from an investment. IRR is the discount rate that will yield a net present value of zero for a given stream of cash flows. This method allows a comparison between the IRR of a project and a company's self-determined discount rate. A financial calculator or computer spreadsheet should be used to determine IRR. In general, if the IRR is greater that the discount rate, the project will be accepted. If the IRR is less than the discount rate, the project will be rejected.

The IRR can provide a convenient way of examining the return that a project will generate. Using the NPV and the IRR approaches result in the same alternative being chosen because these approaches are essentially the same. IRR shows the rate of return that a project generates, while NPV shows the present day dollar value of the return that a project generates. However, IRR analysis ignores the impact of the scale of a project. For example, a project that requires an investment of $100 and returns $125 in one year will have the same IRR as a project that requires a $200,000 investment and returns $250,000 in one year. IRR should only be used to judge if a project is profitable, not for prioritizing projects. Use NPV for prioritizing and comparing projects because it yields consistently valid results.

RECOMMENDATIONS

Net Present Value is generally the most valuable, problem-free measure of profitability. Other indicators that consider the time value of money, such as Internal Rate of Return, are also useful. Payback should be used only for small projects, for a first-cut rough screening analysis, or to complement NPV and IRR information.

If you have accurately estimated cash flows and selected the appropriate discount rate, all projects with a positive NPV are profitable and may be worth implementing. If you have several projects competing for funding, or more than one pollution prevention option, choose the alternative with the highest NPV, not the highest IRR.

❸ Consider Less Tangible Costs.

Pollution prevention projects may have other factors that affect a business that are difficult to quantify, but may still have strategic significance. Issues such as product quality, productivity, market share, customer and stakeholder relations, employee health and safety, public image, a proactive environmental strategy, and criminal and financial liability can be very important criteria in the analysis of a pollution prevention project. Potential liability categories include disposal, storage, transportation, real property damage, civil actions, toxic tort suits, fines, penalties, and criminal liability.

The information for this appendix was adapted from:
Ohio Environmental Protection Agency Pollution Prevention Fact Sheet Number 33, October 1995; as adapted from:

- Northeast Waste Management Officials Association and the Massachusetts Office of Technical Assistance. 1994. "Improving Your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects." Training manual and Instructor's guide (two separate publications). NEWMOA and MA OTA, Boston, MA; and
- White, Allen and Deborah Savage. 1995. "Environmental Cost Accounting and Capital Budgeting." Tellus Institute, Boston, MA. July 12, 1995 Videoconference, Modern Manufacturing series, National Technological University, Fort Collins, Colorado.

APPENDIX G (continued)

Economic Analysis of Pollution Prevention Projects (continued)

Worksheet for Simple Payback

Name of Alternative:_____

Capital Cost Summary:

Cost Item	Cost ($)
Purchased Equipment: price, taxes, insurance, delivery, spare parts inventory	
Materials: electrical, structural, piping, instruments, insulation	
Installation: site demolition, clearing, vendor, contractor, in-house staff	
Utility Connections: electricity, water, refrigeration, steam, fuel, air	
Start-up & Training: engineering	
Other: permitting, fees, plant downtime, new chemicals	
TOTAL CAPITAL COSTS	**$**

Operating Cost and Revenue Summary:

Cost Item	Cost ($)
Increase/decrease in disposal cost: fees, permitting, on-site treatment, taxes	
Increase/decrease raw material cost	
Increase/decrease in utilities cost	
Increase/decrease operation & maintenance labor	
Increase/decrease operation and maintenance supplies	
Increase/decrease in insurance/liabilities cost	
Increase in revenues from increased production	
Increase in revenues from marketable by-product	
Other:	
ANNUAL NET OPERATING COST SAVINGS	**$**

$$\text{Payback Period} = \frac{\text{Total Capital Costs}}{\text{Annual Net Operating Cost Savings}} = \_\_\_\_\_ \text{ Years}$$

APPENDIX H

Documenting Pollution Prevention Progress

Pollution Prevention Progress

Materials/Waste	Reduction Goal	Start Date	Completion Date	% Reduction	Savings
1					
2					
3					
4					
5					
6					
7					

APPENDIX I

THE INDIANA GOVERNOR'S AWARDS FOR EXCELLENCE IN POLLUTION PREVENTION

The Indiana Department of Environmental Management (IDEM), Office of Pollution Prevention and Technical Assistance, P2 program, annually seeks nominations for the Governor's Awards for Excellence in Pollution Prevention. These awards recognize Indiana's leaders who have implemented pollution prevention into their operations and decision-making processes. By utilizing pollution prevention practices, facilities reduce or eliminate hazardous chemicals and waste while saving money on raw materials and disposal cost. Pollution prevention is an important component of Indiana's environmental protection efforts. Pollution prevention benefits the health and welfare of Indiana's communities.

ELIGIBILITY

The Governor's Awards for Excellence in Pollution Prevention are open to all Indiana facilities, state and local units of government and technical assistance organizations that operate or support pollution prevention efforts of outstanding quality. Eligible technical assistance organizations include, but are not limited to: Public entities; educational groups; trade associations; individuals; and public interest, community and labor groups. IDEM welcomes nominations from manufacturers, the energy industry, agriculture and commercial establishments.

The awards program is open to any organization, regardless of size or number of employees. The review committee recognizes the limited resources of small facilities and evaluates the overall effectiveness of the project relative to facility size.

AWARD CATEGORIES

P2 in Practice

This category is for nominees who have implemented one or more innovative pollution prevention projects in the last year. A facility in this category has reduced the use of hazardous materials or the risk of an accident involving the release of a hazardous material through pollution prevention.

Greening the Government

This new award category was approved and announced as part of the Governor's Greening the Government plan in May 2000. This category recognizes those individuals, facilities or agencies within state government that are leaders in implementing pollution prevention programs. Examples include, but are not limited to: agencies that have developed and implemented building equipment operation and maintenance procedures to reduce energy consumption and extend the useful life of equipment and agencies using pollution prevention approaches to address local environmental issues.

Research and Development

This category is for nominees who have developed or are in process of developing new pollution prevention products or technologies.

Energy

This category is for the energy sector. Pollution prevention projects could include: increasing efficiency in energy use, substituting environmentally benign fuel sources and implementing design changes that reduce the demand for energy.

Environmental Management System

This category is for manufacturing facilities and companies that have achieved pollution prevention through a comprehensive environmental management system, such as ISO-14001. Companies must be able to demonstrate their pollution prevention results.

APPENDIX I (Continued)

THE INDIANA GOVERNOR'S AWARDS FOR EXCELLENCE IN POLLUTION PREVENTION (Continued)

Agriculture Education and Outreach

This category addresses education and outreach programs that encourage, promote and assist Indiana Businesses in putting pollution prevention into practice. Such technical assistance programs must result in the actual reduction or elimination of the use of toxic materials or the generation of environmental wastes. Nominees must be able to demonstrate progress and outline methodology for measuring the impact of education and outreach efforts.

Mentor

This category is for organizations that are sharing their pollution prevention successes to benefit the environment and their communities. Examples include, but are not limited to: publicly owned treatment works that have evaluated pollution prevention opportunities for their industrial discharges, manufacturers who encouraged their supplier-vendor chain to incorporate pollution prevention, and/or businesses that have educated industry trade association members to adopt pollution prevention.

Award Selection

A review committee representing industry, academia, government and environmental organizations will evaluate all nominations for completeness, innovation and consistency with the definition of pollution prevention. The review committee selects finalists based on review. IDEM's pollution prevention staff reviews the finalists' environmental, health and safety compliance records. IDEM staff and review committee members perform site visits to confirm project implementation only at those facilities with acceptable compliance records.

This category addresses the agriculture sector. Pollution Prevention includes: implementing procedures that decrease the risk of accidents and environmental harm for workers and others, reducing the use of water and chemical inputs, adopting less environmentally harmful pesticides, cultivating crop strains with natural resistance to pests and protecting ecologically sensitive areas.

The Governor's Awards for Excellence in Pollution Prevention are competitive and recognize only exemplary programs. It is possible no awards will be issued in a particular category. It is also possible that multiple awards may be issued in a particular category.

For Assistance

If you Have questions concerning the awards program or would like assistance completing a nomination, please call:
Awards Coordinator at IDEM's Office of Pollution Prevention and Technical Assistance
(800) 988-7901 or (317) 233-5554
Fax-(317)233-5627, E-Mail: rsteiff@dem.state.in.us.

APPENDIX J

Checklist for Pollution Prevention

Indiana Department of Environmental Management
Office of Pollution Prevention and Technical Assistance

Pollution Prevention Policy and Task Force

	Yes	No
• Does your company have a formal written pollution prevention policy?		
• Have you established a pollution prevention team/task force?		
• Have you considered the opportunity to reduce your regulatory requirements by incorporating pollution prevention practices at your facility?		

Publicizing Your Waste Reduction Efforts

• Do you publicize your company's efforts to reduce waste?		
• Do your marketing strategies incorporate the positive image related to waste reduction?		

Waste Generation and Management

• Are you aware of the potential harmful effects of the hazardous materials and wastes at your facility?		
• Do you and your employees recognize the importance of proper management of hazardous materials and waste reduction?		
• Have you conducted a facility assessment and developed a materials balance/flow diagram for your business?		
• Do you maintain logs on these types and quantities of waste produced by your company so that you can target certain waste for waste reduction opportunities?		
• Do you know the quantity of waste (liquid, solid, gaseous) produced by each process in your business?		
• Have you reevaluated parameters (pH, temperature, concentration, flow, etc.) for the optimal condition your process needs?		

Costs of Generating and Managing Wastes

• Do you calculate the costs of generating and managing wastes? Handling and storage, analysis and reporting, treatment and disposal (including transportation), insurance, training of workers, response planning, safety, potential liabilities (lawsuits, fines, cleanup costs, customer confidence)		
• Can you allocate the costs associated with waste generation to the various processes in your business? (i.e. not "lumped" into overhead)		

Assessing the Cleanliness of Your Facility

• Do you keep your shop clean and orderly to enable you to keep track of chemical handling and process operations?		
• Are there noticeable spills, leaking containers, or water dripping or running?		
• Is there discoloration or corrosion on walls, work surfaces, ceiling, and walls or pipes?		
• Do you see smoke, dirt, or fumes to indicate materials losses?		

APPENDIX J (continued)

Checklist for Pollution Prevention (continued)

	Yes	No
• Do you notice any scrap or out-of-specification parts lying around?	☐	☐
• Are there open containers, stacked drums, shelving too small to properly handle inventory, or other indicators of poor storage procedures?	☐	☐
Employee Training and Involvement		
• Do you continuously train employees in good housekeeping procedures? (spills, leaks, loss prevention, energy, water, and material conservation)	☐	☐
• Are there employee involvement or incentive programs in place to solicit suggestions on improving operations and reducing wastes?	☐	☐
Researching and Utilizing Alternative Products		
• Are you investigating the potential for reformulating the products that require hazardous materials?	☐	☐
• Are you evaluating alternative methods of cleaning?	☐	☐
• Are you investigating the potential for reuse or recycling?	☐	☐
• Are all containers labeled as to their contents and hazards?	☐	☐
Monitoring and Recordkeeping		
• Do you monitor critical parameters and carefully maintain them?	☐	☐
• Do you keep records on the amount of raw materials used per process to monitor process efficiently?	☐	☐

APPENDIX J (continued)

POLLUTION PREVENTION

Make it work for you

How do you rate on pollution prevention?

Answering all of these questions should give you a pretty good idea of how you are doing on pollution prevention. Hopefully they will give you some ideas for doing some things that you are not currently doing.

GENERAL	YES	NO
Do you have a pollution prevention policy?	( )	( )
Do you have a pollution prevention plan or program?	( )	( )
Are your employees actively involved in pollution prevention?	( )	( )
Do you have an employee award or recognition program for accomplishments in pollution prevention?	( )	( )
Have you considered pollution prevention as a way to:		
a. change your hazardous waste generator status?	( )	( )
b. save money?	( )	( )
c. achieve regulatory compliance and avoid add-on controls?	( )	( )
d. meet permit conditions?	( )	( )

PURCHASING		
Does your purchasing policy include pollution prevention concerns?	( )	( )
Do your suppliers provide substitute materials that are less/non toxic?	( )	( )
Will your suppliers take back damaged or outdated materials?	( )	( )
Do your purchasing, environmental, and inventory control personnel communicate with each other to ensure orders match inventory needs without overstocking and having materials become wastes due to limited shelf life?	( )	( )

WASTE TRACKING AND MANAGEMENT		
Can you trace your wastes and emissions back to their source?	( )	( )
Do your consultants, or trade groups help you prevent pollution?	( )	( )
Do you separate toxic materials from non-toxic materials?	( )	( )
Do you consistently emphasize the importance of good housekeeping practices and safe materials handling to your employees?	( )	( )
Have you developed any new technology for pollution prevention that may be patented or shared with other industry groups?	( )	( )

Continued →

APPENDIX J (continued)

POLLUTION PREVENTION (continued)

PUBLIC RELATIONS

Do you promote your product(s), or your firm as being environmentally friendly?	( )	( )
Do your customers demand products that are manufactured in a less polluting process and contain less/no toxic substances, and do you respond to those requests?	( )	( )
Do you have any success stories on pollution prevention that you can publicize or share?	( )	( )
Have you applied for available pollution prevention awards?	( )	( )
Are you concerned about the level of emissions listed on your Toxic Release Inventory forms?	( )	( )
Have you thought about pollution prevention as a way to lower these numbers and make you a better member of your community?	( )	( )

FOLLOW-UP

Would you like more information on pollution prevention?	( )	( )
Can the Indiana Department of Environmental Management's, Office of Pollution Prevention and Technical Assistance (OPPTA), provide you with additional guidance or written materials?	( )	( )

If you answered "yes" to either of the last two questions, you should call (800) 988-7901.

If you answered "no" to any others, we can help.

REFERENCES

State and Federal Pollution Prevention Guides

A Practical Guide to Toxics Use Reductions, Benefiting from TUR at your Workplace, MA EOEA Office of Technical Assistance, 1992.

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Habits of Highly Efficient Alaska Businesses: A Guide to Staying Competitive While Protecting the Environment, Alaska Department of Environmental Conservation, First Edition, June 1997.

Industrial Pollution Prevention Planning, New Jersey Department of Environmental Protection, September 1995.

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Pollution Prevention Planning Procedure, Vermont Department of Environmental Conservation, July 1995.

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